

What is claimed is:

1. An optical data transmission system comprising:

a. a data transmission portion including:

(i) an optical comb generator for generating a comb of discrete optical tones;

(ii) the data transmission portion being arranged in a plurality of segments, each segment of the data transmission portion including at least:

(a) an array of lasers, with each laser in the array of lasers in each segment being injection locked to an optical tone in the comb generated by the optical comb generator;

(b) a data source providing data for modulating the light generated by a majority of the lasers in the array of lasers in each segment; and

(c) a frequency shifter for frequency shifting at least one laser in the array of lasers in each segment, the frequency shifter shifting cooperating with the at least one laser in the array of lasers in each segment to generate a frequency-shifted unmodulated reference signal which occurs in the frequency domain between the discrete optical tones generated by the optical comb generator;

(iii) the data transmission portion also including multiplexers for combining outputs of the modulated lasers and the frequency-shifted unmodulated reference signal and the comb of discrete optical tones onto at least two optical paths;

b. a data receiving portion including:

(i) at least two demultiplexers for demultiplexing signals on the at least two optical paths;

(ii) the data receiving portion being arranged in a plurality of segments, each segment of the data receiving portion including at least:

(a) a photodetector for detecting demultiplexed modulated signals from at least one of the demultiplexers;

- (b) a photodetector for detecting demultiplexed unmodulated signals from at least another of the demultiplexers;
- (c) a filter array associated with each photodetector in each segment, the filter array selecting a desired modulated tone and an associated desired unmodulated tone between the discrete optical tones generated by the optical comb generator; and
- (d) a mixer for detecting the filtered demultiplexed modulated signals and the filtered demultiplexed unmodulated signals to recover at least a portion of the data provided by the data source.
2. The optical data transmission system of claim 1 wherein the filter array in the data receiving portion comprises an array of bandpass filters and an array of switches for selectively enabling the filters.
3. The optical data transmission system of claim 2 wherein the array of switches is an array of MEM switches.
4. The optical data transmission system of claim 1 wherein the light generated by the majority of the lasers in at least one segment is modulated by modulating the majority of the lasers in the array of lasers.
5. The optical data transmission system of claim 1 wherein the lasers in at least one segment are laser diodes.
6. An optical data transmitter comprising:
- (a) an optical comb generator for generating a comb of discrete optical tones;
  - (b) at least one transmitter segment, said at least one transmitter segment and any additional transmitter segments including at least:

(i) an array of lasers, with each laser in the array of lasers in each segment being injection locked to an optical tone in the comb generated by the optical comb generator;

(ii) a data source providing data for modulating the light generated by a majority of the lasers in the array of lasers in each segment; and

(iii) a frequency shifter for frequency shifting at least one laser in the array of lasers in each segment, the frequency shifter shifting cooperating with the at least one laser in the array of lasers in each segment to generate a frequency-shifted unmodulated reference signal which occurs in the frequency domain between the discrete optical tones generated by the optical comb generator;

(c) multiplexers for combining outputs of the modulated lasers and the frequency-shifted unmodulated reference signal and the comb of discrete optical tones onto at least two optical paths.

7. The optical data transmitter of claim 6 wherein the filter array in the data receiving portion comprises an array of bandpass filters and an array of switches for selectively enabling the filters.

8. The optical data transmitter of claim 7 wherein the array of switches is an array of MEM switches.

9. The optical data transmitter of claim 6 wherein the light generated by the majority of the lasers in at least one segment is modulated by modulating the majority of the lasers in the array of lasers.

10. The optical data transmitter of claim 6 wherein the lasers in said at least one transmitter segment are laser diodes.

11. An optical data receiver comprising:

- (a) an optical comb generator for generating a comb of discrete optical tones;
- (b) at least two demultiplexers for demultiplexing signals on at least two optical paths; and
- (c) at least one receiver segment, said at least one receiver segment and any additional receiver segments including at least:

- (i) a photodetector for detecting demultiplexed modulated signals from at least one of the demultiplexers;

- (ii) a photodetector for detecting demultiplexed unmodulated signals from at least another of the demultiplexers;

- (iii) a filter array associated with each photodetector in each segment, the filter array selecting a desired modulated tone and an associated desired unmodulated tone between the discrete optical tones generated by the optical comb generator; and

- (iv) a mixer for detecting the filtered demultiplexed modulated signals and the filtered demultiplexed unmodulated signals to recover at least a portion of the data provided by the data source.

12. The optical data receiver of claim 11 wherein the filter array in the data receiving portion comprises an array of bandpass filters and an array of switches for selectively enabling the filters.

13. The optical data receiver of claim 12 wherein the array of switches is an array of MEM switches.

14. The optical data receiver of claim 11 wherein the light generated by the majority of the lasers in at least one segment is modulated by modulating the majority of the lasers in the array of lasers.

15. The optical data receiver of claim 11 wherein the lasers in said at least one receiver segment are laser diodes.
- 5 16. A method of optically modulating and transmitting source data comprising:  
(a) generating an optical comb comprising optical tones having a frequency spacing equal to  $\Delta f$ ;  
(b) modulating selected ones of the optical tones in the optical comb according to the source data to produce a comb of modulated optical tones;  
10 (c) frequency shifting at least one optical tone in the optical comb by a frequency less than  $\Delta f$  to produce a frequency shifted unmodulated optical reference tone; and  
(d) multiplexing the optical comb, the frequency shifted unmodulated optical reference tone and the comb of modulated tones onto at least one optical path.
- 15 17. The method of claim 16 wherein the optical tones are generated by an optical comb generator and are divided into segments of optical tones, each segment of optical tones having a frequency shifted unmodulated optical reference tone and a plurality of modulated tones, the tones of each segment being multiplexed by a segment multiplexer associated with each segment.
- 20 18. The method of claim 17 wherein an output of each segment multiplexer is applied to a first wavelength multiplexer and wherein the frequency shifted unmodulated optical reference tone of each segment and the optical comb generated by the optical comb generator are applied to a second wavelength multiplexer.
- 25 19. The method of claim 16 wherein the of modulating selected ones of the optical tones in the optical comb is accomplished by modulating an output of each laser in a set of lasers which are optically injection-locked to different optical tones in the optical comb.

20. The method of claim 19 wherein the output of each laser in a set of lasers is modulated by direct intensity modulation of each laser.

21. A method of receiving and demodulating source data, which has been optically modulated and transmitted according to the method of claim 16, the method of receiving comprising:

(a) optically demultiplexing the multiplexed optical comb, the frequency shifted unmodulated optical reference tone and the comb of modulated tones in at least one demultiplexer;

(b) photodetecting in a first photodetector modulated tones provided via the at least one demultiplexer;

(c) photodetecting in a second photodetector unmodulated tones provided via the at least one demultiplexer; and

(d) filtering and mixing outputs of the first and second photodetectors.

22. The method of claim 21 wherein the optical tones are generated by an optical comb generator and are divided into segments of optical tones, each segment of optical tones having a frequency shifted unmodulated optical reference tone and a plurality of modulated tones, the tones of each segment being multiplexed by a segment multiplexer associated with each segment and, when demultiplexed in accordance with the aforementioned optically demultiplexing, being separated again into segments.

23. A data transmitter comprising:

(a) an optical comb generator for generating a comb of discrete optical tones;

(b) at least one transmitter segment, said at least one transmitter segment and any additional transmitter segments including at least:

(i) an array of lasers, with each laser in the array of lasers in said at least one segment being injection locked to an optical tone in the comb generated by the optical comb generator;

(ii) a data source providing data for modulating the light generated by at least a majority of the lasers in the array of lasers in each segment; and  
(iii) a frequency shifter for frequency shifting at least one laser in the array of lasers in each segment, the frequency shifter cooperating with the at least one laser in the array of lasers in said at least one segment to generate a frequency-shifted unmodulated reference signal which occurs in the frequency domain between the discrete optical tones generated by the optical comb generator;  
(iv) a photodetector for photodetecting the outputs of the array of lasers to thereby produce a RF comb of modulated carriers, the carriers corresponding to the frequencies of the optical tones in the comb generated by the optical comb generator; and  
(v) a filter array for selecting a desired one of the modulated carriers in said RF comb of modulated carriers.

24. The data transmitter of claim 23 wherein the filter array comprises an array of bandpass filters and an array of switches for selectively enabling the filters.

25. The data transmitter of claim 24 wherein the array of switches is an array of MEM switches.

26. The data transmitter of claim 23 wherein the light generated by the majority of the lasers in at least one segment is modulated by modulating the majority of the lasers in the array of lasers.

27. The optical data transmitter of claim 23 wherein the lasers in said at least one segment are laser diodes.